

Falcon 128 x 32 Geiger-Mode Flash 3-D LiDAR Camera



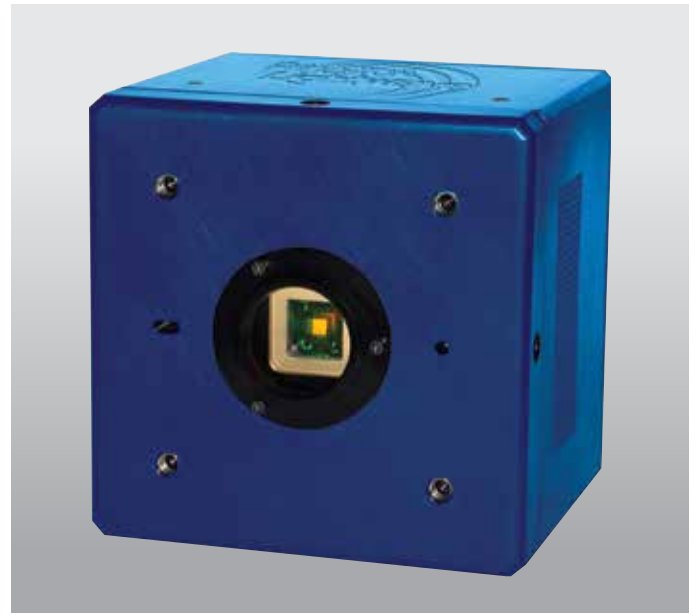
The Falcon provides the most versatile imaging capability in the near infrared for photon starved environments. Based on Princeton Lightwave's expertise in InGaAs Geiger-mode avalanche photodiodes, each of the Falcon's 128 x 32 pixels is capable of detecting a single photon to within 500 ps resolution. The Falcon is typically used for collecting returns from the flash of a 1.0 μm or 1.5 μm laser in range finding applications, providing time-of-flight resolution of 7.5 cm. Its 8,000 period clock provides a range depth of 600 meters, and when the clock is slowed to its maximum period of 5 ns, a range depth of 6 km. The user can program the triggering of the clock for imaging the particular range depth of interest desired. The Falcon is capable of collecting 400 million pixel measurement returns per second.

Applications

- Geiger-mode LiDAR from 1.0 μm to 1.6 μm
- Target detection, acquisition, and ranging
- 3-D mapping with 7.5 cm resolution per return
 - Foliage penetration with <23 cm differentiation
 - Coverage of >1,000 km^2/hr . at 2 points/ m^2
 - >10 points/ m^2 at 2^{12} relative intensity
- Autonomous navigation
- Passive imaging in photon-starved environments

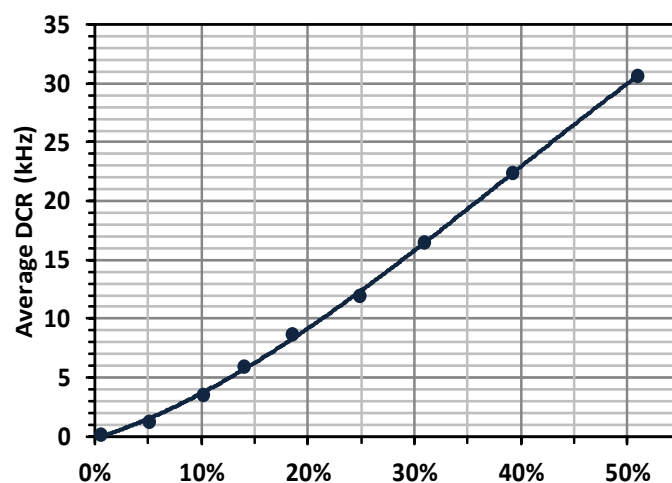
Key Features and Benefits

- 500 ps, 7.5 cm time-of-flight resolution per return
- 128 x 32 focal plane array for 3-D point cloud imaging
- Maximum range depth to 6,000 meters per flash
- Triggerable to 90,000 times per second
- Measures up to 400 million pixels per second
- Low SWaP: 900 cm^3 ; 1.3 kg; 18 W consumption



Chassis C-mount for lens attachment

Falcon - 1064 nm Dark Count Rate vs. Photon Detection Efficiency



Specifications for 1.064 μm PART NO.: CAM-G4096-S10-00 (CameraLink version); CAM-G4096-S10-X0 (CoaXPress® Version)
 Operating Conditions: 25°C ambient temperature. PDE tested under collimated input conditions

Parameter	Symbol	Conditions	Min	Typ.	Max	Units	
Camera Configuration and Operating Conditions							
Array Format			128 x 32				
Array Dimensions			6.4 x 1.6			mm	
Wavelength Range	λ		1020		1140	nm	
Time Bin Duration	T_{bin}	user-defined	0.5		5.0	ns	
Gate Duration	T_{gate}	user-defined in 4 ns increments	4		$T_{\text{bin}} \cdot 8000$	ns	
Maximum Frame Rate	FR_{max}	For range gates up to 4.0 μs ; three CameraLink configurations	Full			72.1	kHz
			Medium			37.0	
			Base			18.7	
Maximum Frame Rate	FR_{max}	For range gates up to 4.0 μs ; CoaXPress® version			90	kHz	
Power Consumption	P_c	at maximum frame rate			22	W	
Input Voltage	V_{in}		12		36	V	
Input Current	I_{in}				1.8	A	
Operating Temperature	T_{op}	case temperature	0		40	°C	
Relative Humidity	RH	non-condensing	10		95	%	
Weight	Wt	no lens		1.3		kg	
Electro-optic Performance Summary							
Operable Pixels	N_{op}	DCR and PDE within $\pm 4\sigma$ of average values	95			%	
Mean Photon Detection Efficiency	PDE	$\lambda = 1064 \text{ nm}$	25			%	
PDE Standard Deviation	σ_{PDE}	$\lambda = 1064 \text{ nm}$			6.5	%	
Mean Dark Count Rate	DCR				30	kHz	
DCR Standard Deviation	σ_{DCR}				6	kHz	
Timing Jitter	TJ	Standard deviation of jitter			650	ps	
Total Cumulative Crosstalk Probability	$P_{\text{xt}}(\text{tot})$	Prob. of 1 or more crosstalk events per primary avalanche in 15 x 15 subarray; PDE = 25%			15	%	
Crosstalk Probability for >1 Event	$P_{\text{xt}}(n>1)$	Prob. of > 1 crosstalk event per primary avalanche in 15 x 15 subarray; PDE = 25%		1.5		%	

Specifications for 1.55 μm PART NO.: CAM-G4096-S15-00 (CameraLink version); CAM-G4096-S15-X0 (CoaXPress® Version)
 Operating Conditions: 25°C ambient temperature. PDE tested under collimated input conditions

Parameter	Symbol	Conditions	Min	Typ.	Max	Units
Camera Configuration and Operating Conditions						
Array Format			128 x 32			
Array Dimensions			6.4 x 1.6			mm
Wavelength Range	λ		1400		1620	nm
Time Bin Duration	T_{bin}	user-defined	0.5		5.0	ns
Gate Duration	T_{gate}	user-defined in 4 ns increments	4		$T_{\text{bin}} \cdot 8000$	ns
Maximum Frame Rate	FR_{max}	For range gates up to 4.0 μs ; three CameraLink configurations	Full		72.1	kHz
			Medium		37.0	
			Base		18.7	
Maximum Frame Rate	FR_{max}	For range gates up to 4.0 μs ; CoaXPress® version			90	kHz
Power Consumption	P_c	at maximum frame rate			26	W
Input Voltage	V_{in}		12		36	V
Input Current	I_{in}				1.8	A
Operating Temperature	T_{op}	case temperature	0		40	°C
Relative Humidity	RH	non-condensing	10		95	%
Weight	Wt	no lens		1.3		kg
Electro-optic Performance Summary						
Operable Pixels	N_{op}	DCR and PDE within $\pm 4\sigma$ of average values	95			%
Mean Photon Detection Efficiency	PDE	$\lambda = 1550 \text{ nm}$	16			%
PDE Standard Deviation	σ_{PDE}	$\lambda = 1550 \text{ nm}$			6.5	%
Mean Dark Count Rate	DCR				50	kHz
DCR Standard Deviation	σ_{DCR}				20	kHz
Timing Jitter	TJ	Standard deviation of jitter			650	ps
Total Cumulative Crosstalk Probability	$P_{\text{xt}}(\text{tot})$	Prob. of 1 or more crosstalk events per primary avalanche in 15 x 15 subarray; PDE = 16%		20		%
Crosstalk Probability for >1 Event	$P_{\text{xt}}(n>1)$	Prob. of > 1 crosstalk event per primary avalanche in 15 x 15 subarray; PDE = 16%		10		%

Specification for Falcon 1064/1550 Camera System Components

- Windows 7 64-bit Professional Operating System with 3.2 GHz Quad Core Intel i7 Processor
- 4 GB System RAM
- 512 GB solid state drive for operating system and for data storage at full frame rate
- 2 TB Hard Drive for data archiving
- National Instruments PCIe-1433 CameraLink Frame Grabber Interface (CoaXPress® optional)
- 24" LCD Monitor, Wireless Keyboard, and Mouse
- Comprehensive GUI Camera Software enabling execution of all camera functions and visual display
- Power Cables, Two 3-meter CameraLink Cables (CoaXPress® optional), and Trigger/External Clock Cables

Ordering Information

CAM-G4096-S10-00 for air-cooled CameraLink version;
CAM-G4096-S10-01 for liquid-cooled CameraLink version;
CAM-G4096-S10-X0 for air-cooled CoaXPress® version;
CAM-G4096-S10-X1 for liquid-cooled CoaXPress® version

Falcon 128 x 32 Geiger-mode Flash 3-D LiDAR Camera for 1020 to 1140 nm use (previously known as the CAM128X32A-GMA-0 synchronous camera)

CAM-G4096-S15-00 for air-cooled CameraLink version;
CAM-G4096-S15-01 for liquid-cooled CameraLink version;
CAM-G4096-S15-X0 for air-cooled CoaXPress® version;
CAM-G4096-S15-X1 for liquid-cooled CoaXPress® version;

Falcon 128 x 32 Geiger-mode Flash 3-D LiDAR Camera for 1400 to 1620 nm use (previously known as the CAM128X32B-GMA-0 synchronous camera)

Camera System Features

Control Interface Control of camera functions is supported by the CameraLink or CoaXPress® control channel using a comprehensive serial command set. The PC graphical user interface (GUI) allows for simple camera configuration and control, and custom software can be developed by the user utilizing the serial command set. The camera supports both internal and external master clocks, as well as internal and external triggering for image acquisition.

Sensitivity Settings The photon detection efficiency (PDE) is determined by a user-specified “sensitivity” setting from 1 to 100. A factory calibration of sensitivity versus average PDE is provided with each camera.

Temperature and Bias Control The APD array temperature is managed by an internal temperature control module with programmable set-point and temperature monitoring functions. Sensor temperature and APD bias are handled automatically. Ambient and FPA-level temperatures are monitored in real time, and if ambient temperature conditions change, the camera automatically adjusts temperature set-points and FPA bias levels to maintain a fixed sensitivity.

These and additional features are fully detailed in the Interface Control Document, available under NDA. To request, please email sales@princetonlightwave.com

Specifications subject to change without notice

Princeton Lightwave GmAPD camera products and associated technical data are subject to the controls of the International Traffic in Arms Regulations (ITAR). Export, re-export, or transfer of these items by any means to a foreign person or entity, whether in the US or abroad, without appropriate US State Department authorization, is prohibited.

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